Claims

What is claimed is:

1. A method for forming a ruthenium metal layer comprising the following steps:

providing a ruthenium precursor and oxygen in a chamber to form a ruthenium oxide layer; and

heating said ruthenium oxide layer in the presence of a hydrogen-rich gas to form a ruthenium metal layer.

2. The method of claim 1 further comprising the step of introducing oxygen into said chamber at a flow rate of between about 10 sccm to about 1000 sccm during said step of providing said precursor and said oxygen in said chamber.

3. The method of claim 1 further comprising the step of introducing oxygen into said chamber at a flow rate of between about 150 sccm to about 250 sccm during said step of providing said precursor and said oxygen in said chamber.

4. A method for forming a ruthenium metal layer comprising the following steps:

providing a ruthenium precursor at a flow rate of between about 10 sccm and about 2000 sccm and oxygen at a flow rate of between about 10 sccm and about 1000 sccm in a chamber at a pressure of between about 0.1 Torr and about 90 Torr and at a temperature of between about 100°C and about 600°C to form a ruthenium oxide layer; and

heating said ruthenium oxide layer to a temperature of between about 400°C to about 800°C for between about 10 seconds and about five minutes at a pressure of between about 1 Torr and about 760 Torr in the presence of a hydrogen-rich gas at a flow rate of between about 100 sccm and about 10,000 sccm.

5. The method of claim 4 wherein said step of providing said ruthenium precursor comprises the step of providing a material selected from the group consisting of CHDR, $Ru(EtCp)_2$, and $Ru(OD)_3$.

6. The method of claim 4 further comprising the step of providing a hydrogen-rich gas selected from the group consisting of ammonia and hydrogen gas during said heating step.

7. A method used to form a ruthenium metal layer comprising the following steps:

forming a ruthenium oxide layer in a chamber by providing a ruthenium precursor at a flow rate of between about 10 sccm and about 2000 sccm and oxygen at a flow rate of between about 10 sccm and about 1000 sccm at a temperature of between about 100°C and about 600°C and a pressure of between about 0.1 Torr to about 90 Torr; and

annealing said ruthenium oxide layer at a temperature of between about 400°C and about 800°C in the presence of a hydrogen-rich gas at a flow rate of between about 100 sccm and about 10,000 sccm and a chamber pressure of between about 1 Torr and about 760 Torr.

8. The method of claim 7 further comprising the following steps:

forming said ruthenium oxide layer in said chamber by providing said ruthenium precursor at a flow rate of between about 100 sccm and about 1000 sccm and said oxygen at a flow rate of between about 100 sccm and about 1000 sccm at a temperature of between about 150°C and about 450°C and a pressure of between about 1 Torr to about 9 Torr; and

during said annealing step, heating said ruthenium oxide layer to a temperature of between about 450°C and about 750°C in the presence of a hydrogen-rich gas at a flow rate of between about 500 sccm and about 8,000 sccm at a pressure of between about 100 Torr to about 660 Torr.

9. The method of claim 8 further comprising the following steps:

forming said ruthenium oxide layer in said chamber by providing said ruthenium precursor at a flow rate of about 500 sccm and said oxygen at a flow rate of about 200 sccm and a temperature of about 210°C; and

during said annealing step, heating said ruthenium oxide layer to a temperature of between about 475°C to about 650°C in the presence of a hydrogen-rich gas at a flow rate of between about 3,000 sccm and about 6,000 sccm.

10. The method of claim 9 further comprising the step of annealing said ruthenium oxide layer for a duration of between about 10 seconds and about five minutes during said annealing step.

11. The method of claim 10 further comprising the step of annealing said ruthenium oxide layer for a duration of between about 30 seconds and about three minutes.

12. A method used during the formation of a semiconductor device comprising the following steps:

providing a ruthenium precursor and oxygen in a chamber to form a ruthenium oxide layer; and

heating said ruthenium oxide layer in the presence of a hydrogen-rich gas to form a ruthenium metal layer;

forming a patterned photoresist layer over said ruthenium metal layer; and

etching said ruthenium metal layer using said photoresist layer as a pattern to define a semiconductor device portion.

13. The method of claim 12 wherein said step of etching said ruthenium metal layer further comprises the step of defining a plurality of transistor control gates.

14. The method of claim 12 wherein said step of etching said ruthenium metal layer further comprises the step of defining a portion of a semiconductor device capacitor.

15. The method of claim 12 further comprising the following steps:

providing said ruthenium precursor at a flow rate of between about 10 sccm and about 2000 sccm and said oxygen at a flow rate of between about 10 sccm and about 1000 sccm in said chamber at a pressure of between about 0.1 Torr and about 90 Torr and at a temperature of between about 100°C and about 600°C during said step of providing said ruthenium precursor and said oxygen in said chamber; and

during said heating step, heating said ruthenium oxide layer to a temperature of between about 400°C to about 800°C for between about 10 seconds and about five minutes in the presence of a hydrogen-rich gas at a flow rate of between about 100 sccm and about 10,000 sccm at a chamber pressure of between about 1 Torr and about 760 Torr.

16. The method of claim 12 further comprising the following steps:

providing said ruthenium precursor at a flow rate of between about 100 sccm and about 1000 sccm and said oxygen at a flow rate of between about 150 sccm and about 250 sccm in said chamber at a pressure of between about 1.0 Torr and about 9.0 Torr and at a temperature of between about 150°C and about 450°C during said step of providing said ruthenium precursor and said oxygen in said chamber; and

during said heating step, heating said ruthenium oxide layer to a temperature of between about 475°C to about 750°C for between about 30 seconds and about three minutes in the presence of a hydrogen-rich gas at a flow rate of between about 500 sccm and about 8,000 sccm at a chamber at a pressure of between about 100 Torr and about 660 Torr.

17. The method of claim 12 further comprising the following steps:

providing said ruthenium precursor at a flow rate of about 500 sccm and said oxygen at a flow rate of about 200 sccm in said chamber at a pressure of between about 1.0 Torr and about 9.0 Torr and at a temperature of about 210°C during said step of providing said ruthenium precursor and said oxygen in said chamber; and

during said heating step, heating said ruthenium oxide layer to a temperature of between about 475°C to about 650°C for about one minute in the presence of a hydrogen-rich gas at a flow rate of between about 3,000 sccm and about 6,000 sccm at a chamber at a pressure of between about 100 Torr and about 660 Torr.

18. A method used during the formation of a semiconductor device comprising the following steps:

forming a blanket conductive layer over a wafer substrate assembly;

providing a ruthenium precursor and oxygen in a chamber to form a ruthenium oxide layer directly on said blanket conductive layer; and

heating said ruthenium oxide layer in the presence of a hydrogen-rich gas to form a ruthenium metal layer.

19. The method of claim 18 wherein said step of forming said ruthenium metal layer forms a layer having regions of isolated ruthenium metal electrically coupled by said blanket conductive layer.

20. The method of claim 18 further comprising the step of forming layer selected from the group consisting of tungsten nitride and tantalum nitride during said step of forming said blanket conductive layer.